Vascular Surgical Disease

Eagle’s Criteria in Prediction of Perioperative Cardiac Mortality

<table>
<thead>
<tr>
<th># of risk factors</th>
<th>Risk</th>
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<tbody>
<tr>
<td>Age &gt; 70 years</td>
<td>0 3.1% risk of MI, good to go</td>
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<tr>
<td>Diabetes mellitus</td>
<td>1-2 15% risk of MI, need DTS</td>
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<tr>
<td>Angina</td>
<td>3+ 50% risk of MI, need angio</td>
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<tr>
<td>Ventricular arrhythmia requiring treatment</td>
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<td>Q waves on preoperative ECG</td>
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<td>DTS redistribution</td>
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Atherosclerosis

Risk Factors: cigarette smoking, hypertension, dyslipidemias, DM, obesity, coagulation disorders, regions of turbulence
Sequelae: MI, CVA, lower extremity ischemia

Aneurysm: Defined as a dilation 1.5 x normal

- Note: aneurysm is all layers, dissection is disruption of intima, pseudoaneurism is extravascular hematoma
- 90% are related to atherosclerosis: ↓ diffusion of nutrients + ↑ matrix metalloproteinases
- 11x ↑ risk with first-degree relative

Diagnosis: presents as pulsatile mass or distal ischemia from embolization
Tests: Ultrasound is 95% sensitive for AAA + peripheral aneurysms

Natural History

- Rupture: 60% mortality rate. Don’t resuscitate in ER, go straight to the OR for resuscitation.
- 4cm dilation: 5% rupture, 6cm dilation: 15% rupture (annual risk)
- Popliteal is 50% associated with concurrent AAA, and 75% of popliteal are bilateral

Treatment

- Indications: 5+ cm, symptomatic, enlarging more than 4mm/year
  - <5cm: 4% rupture per year, 5-7cm: 7% rupture per year, >7cm: 19% rupture per year
  - <5cm is lower risk to not operate (4%) than to operate (5%)
- Operative mortality: 5% in low-risk. Only operate if risk of NOT operating is higher.
  - AAA: Endovascular: better results but requires more intense follow up. Repair if >4.5cm
  - Popliteal: Open repair is better. Repair if >2cm.

Complications of treatment

- MI, arrhythmia, renal failure, graft rejection
- Aortoenteric fistula (50% mortality, increased risk with infection)
- Colonic ischemia (suspect if postop diarrhea)
  - Most commonly involves rectosigmoid due to ligating inferior mesenteric artery
  - Diagnose with sigmoidoscopy
  - If limited to the mucosa: bowel rest, hydrate, NG tube, antibiotic
  - Full thickness involvement requires resection
- Major fluid shifts: Large third-space losses that are mobilized by the third day
- Graft infection: most commonly staph aureus/epidermidis. Graft needs to be removed.
- Impotence: hypogastric artery ligation, autonomic nerve ligation

Aortic Dissection: Tear in the intima

- Can reach aortic valve, coronary vessels, aortic root --> tamponade

Symptoms: “tearing” chest pain radiating to the back, hypertension (200s / 100s), diaphoresis

Diagnosis: TEE, CT, angiography

Treatment: ↓ BP + HR to ↓ wall stress. Use beta blockers.
- Surgery if Stanford A (ascending aorta) or B (descending) w/renal, mesenteric involvement
Chronic Intestinal Ischemia
Symptoms: Postprandial pain, weight loss
Diagnosis: Duplex, mesenteric angiography
Treatment: Endarterectomy. Bypass with saphenous. Balloon angioplasty is difficult because of tortuosity of vessels

Renal Artery Stenosis
Types: Atherosclerotic (proximal), Fibromuscular (distal + bilateral in 50%)
Diagnosis
- Renal duplex
- IV Urography
- Captopril Challenge Test: Positive if renin ↑↑↑. Contraindicated in bilateral since GFR ↓
Treatment
- Atherosclerotic: Metallic stent
- Fibromuscular: Percutaneous transluminal balloon angioplasty (PTA) 95% cure rate

Acute Arterial Occlusion
- 80% result form emboli from the left side of the heart
  ○ Atrial fibrillation or from akinetic regions due to prior MI
- Most common sites: femoral artery (45%), popliteal artery (15%), common iliac (15%), aorta (15%)
Symptoms: “six Ps”: Pulseless, Poikilothermic, Pallor, Parasthesias, Paralysis, Painful
Treatment: more than 6 hours after ischemia may result in permanent damage/amputation
- IV Heparin: (contraindicated if GI bleed, new neuro defect, head injury, ongoing bleed)
- Mannitol: helps hemodilute blood by drawing fluid into the intravascular compartment
- Dextran: carbohydrates ↑ electronegativity of RBCs, platelets: repulse vessel wall
- Proceed to the OR for a balloon catheter embolectomy (Fogarty) (92% limb salvage)
  ○ Complication: Ischemia-Reperfusion Injury (Compartment Syndrome)
    ■ Results from edema of the muscle
    ■ As compartment pressure approaches 20-40 mmHg irreversible ischemic injury may occur
    ■ Treatment: Fasciotomy, long-term treatment with Warfarin

Chronic Peripheral Arterial Occlusive Disease
Factors: # and severity of occlusions, degree of collateralization, subjective tolerance
Symptoms: Pain, Pulselessness, Poikilothermia, Pallor, Parasthesias, Paralysis
Signs: Bruits, loss of hair, ulcers, thrills, Buerger’s sign: rubor when dependent, pale when elevated
Types:
- Femoropopliteal: Below inguinal ligament: --> Hunter's (adductor) canal
  ○ Most common site. Typically occurs at the adductor hiatus
- Tibial occlusive disease: distal to popliteal artery trifurcation
  ○ Most common in: diabetes, ESRD, advanced age
- Aortoiliac: Leriche Syndrome: Impotence, no femoral pulse, claudication, buttock muscle wasting
  ○ Generally a progressive disease that will fail medical management. PTA works best here.
- Superficial Femoral: Calf claudication
Diagnosis:
- Doppler: Triphasic waveform (healthy). Systole, backflow as elastic arteries recoil, forward in diastole
  ○ Ankle-Brachial Index (ABI). 0.8: claudicaiton, 0.4: rest pain (in ratio of mmHg)
- Angiography
  ○ Not done unless symptoms worsen after trial of medical therapy. Is essentially a preoperative study.
    ○ Seldinger technique: selective arteriography in periphery
  ○ Complications: bleeding, thrombosis, pseudoaneurysm, hypersensitivity reaction, nephropathy
Treatment: Medical management unless lifestyle-limiting, rest pain, gangrene: contrast arteriography or MRA
70% remain stable or improve, 20% progress and require revascularization, 10% require amputation
The more distal and more severe the disease, the more likely the graft is to fail.

- **Medical:**
  - Exercise! 33% improve
  - 50% relief with quitting smoking alone
  - Cilostazol (PDE inhibitor. Platelet aggregation ↓), Pentoxyphylline (xanthine) cAMP ↑, helps RBCs deform
- **Surgical**
  - Endovascular: Restenosis in 20-50% @ 1 year
    - Infrapopliteal is especially bad, 60% restenose. Only indication is to heal an ulcer or salvage limb
    - Works best in single, short segment iliac stenosis. Not as good in common iliac.
  - Bypass:
    - Aortofemoral: 90% 5 year patency with mesh
    - Femoropopliteal: use vein graft. 90% patency if good follow up with duplex ultrasound etc
  - Complications:
    - Postoperative: “Trash foot”: atheroembolization of fibrin, platelets, debris. Painful, cyanotic. If a good anastomosis was performed, this will most likely heal.
    - Perioperative: 10% MI, arrhythmia, heart failure
      - Medium cardiac risk: preoperative DTS scan (dipyridamole-thallium scintigraphy)
        - Good negative predictive value (96-99%) ruling out cardiac ischemia
      - High risk (EF<20%): preoperative coronary angiography
        - Often first get prophylactic CABG
      - Clamping: highest CV risk due to ↑ afterload.
      - Unclamping: ↓ afterload causing hypotension, acidosis/hyperkalemia, arrhythmias

**Cerebrovascular Insufficiency**
- Stroke is the 3rd leading cause of death in US. 75% embolic, 25% hemorrhagic
- Circle of Willis: good collateral circulation but complete in only 25% of people

**Physiology:** 15% of cardiac output. Normal: 100ml/100g brain matter, Ischemia @ 18ml, infarction @ 8ml

**Symptoms:**
- Bruits, but does NOT correlate with severity. A completely occluded artery has no bruit.
- Hollenhorst plaques: yellow refractile particles seen on opthalmogic exam @ branch pt of retinal a., represent cholesterol emboli

**Diagnosis:**
- **Doppler/Duplex:** can determine type (soft, calcified, ulcerated) and location
  - Limitation: cannot see intracranial lesions.
  - Best for carotid plaques. 90% sensitive
- **Arteriography:** Gold standard. Best for aortic arch, intracranial lesions. **Complications:** 0.5% CVA
- **MRI/MRA:** best for detection of brain infarction, tumor, AVM, hemorrhage

**Treatment**
- 70% stenosis (symptomatic, NASCET trial): medical (26% risk of CVA), CEA (9% risk of CVA)
- 60% stenosis (asymptomatic, ACAS trial): medical (10.6% risk of CVA), CEA (4.8% risk of CVA)
- **CEA**
  - Perioperative mortality of 2%
  - Other complications: hypoglossal injury, vagus injury, facial nerve injury
  - Can be performed with local or regional anesthesia if needed
  - Monitor neurologic function during carotid clamping: **use EEG**
  - Restenosis: 13% 5 year risk
  - Can be performed as early as 2-4 weeks after a frank stroke if the patient's neurologic status stabilizes
Vertebral Basilar Disease
- “Subclavian Steal Syndrome”: during exercise, resistance ↓ in arm vessels, backflow occurs in vertebral arteries
- More common in left because left supraventricular artery is 4x longer than right

Symptoms: lightheadedness, syncopy, nausea
Signs: Supraventricular bruises
Treatment: Carotid-subclavian bypass: subclavian is reimplemented in common carotid.

Venous Disease: 40% of adults have
- Examples: postthrombotic syndrome, ulcers, spider veins, telangiectasias

Anatomy
- Central veins: SVC, IVC, Iliac, Subclavian
- Peripheral veins
  - Superficial: Greater saphenous (drains to femoral triangle), Lesser saphenous (popliteal v)
  - Deep: Common femoral v, (Superficial) femoral v, Profunda femoris v.
    ■Anterior tibial vv, Posterior Tibial vv, Fibular (Peroneal) vv. (each are paired)
    - Drain to popliteal v and then (superficial) femoral v. (which is a deep vein)
    - Popliteal v. is the continuation of the (superficial) femoral after it exits adductor canal

Pathophysiology
- Bicuspid valves direct flow from superficial to deep
- Incompetence results in: varicosities, chronic venous insufficiency, venous ulcers

Deep Venous Thrombosis: Occurs in 20% of general surgeries, and 70% of major orthopedic surgeries
Symptoms: 50% are asymptomatic, remainder have pain secondary to inflammation and edema
- Phlegmasia cerula dolens: inflammation-cyanosis-painful
- Most reliable sign: new-onset unilateral leg swelling
Iliac: 4x more common on the left because aortic bifurcation overlies left side
Risk factors: Virchow’s Triad: 1) Endothelial injury, 2) Stasis, and 3) Hypercoagulable state
Diagnosis:
- Homan’s sign: 50% sensitive
- Duplex ultrasound: 95% sensitive

Treatment
- IV heparin, 70-100 U/kg bolus (Also has anti-inflammatory effects). Bed rest. Warfarin 3-6 months.
- Prophylaxis: Sequential compression device, subcutaneous heparin (↑ ATIII), early ambulation
- Fibrinolysis if subclavian DVT, acute renal vein thrombosis, acute SVC thrombosis
- Long-term: Warfarin therapy for 3-6 months. Remain on heparin for early part of course to avoid hypercoagulable state due to Protein C & S inhibition.

Complications
- Recurrence. Most common in first few months.
- Postthrombotic syndrome (10%): chronic edema, ulceration, claudication. Results from chronic venous HTN
- Heparin-induced thrombocytopenia (5%): paradoxical arterial thrombosis
Pulmonary Embolus

Symptoms: Pleuritic chest pain (70%), dyspnea and tachypnea (80%), tachycardia (45%), Hemoptyisis (25-30%), Right sided heart strain seen on ECG

Pathophysiology
- Many small emboli cause cardiovascular collapse as often as one large embolus
- 90% originate in the lower extremities

Diagnosis:
- CXR (rarely diagnostic): pleural effusion (33%), wedge-shaped atelectasis (Westermark sign) (rare).
  - Rule out other causes: pneumothorax, pneumonia, large atelectasis
  - Makes V/Q scan more useful.
- ECG to rule out MI
- ABG: decreased PCO$_2$ due to hyperventilation
- Chest CT (helical)
- Ventilation-perfusion (V/Q) scan: Radioactive xenon gas inhaled. Very good except for saddle embolus.
  - Segmental defect: 90% PPV
  - Sub-segmental defect: Equivocal (not diagnostic, but doesn’t rule it out)
- Pulmonary angiograph: 98% sensitive, but is invasive

Treatment
- Anticoagulation
- Evaluation of inherited hypercoagulability is indicated in spontaneous PE
- If stable, inotropic support
- If unstable as a result of the PE, thrombolytic therapy is considered
- Percutaneous pulmonary embolectomy suction indications:
  - Large clot in pulmonary artery
- Trendelenburg operation indications:
  - Patient becomes profoundly hypotensive and hypoxic despite intubation and vasopressors
  - Mortality rate: 80%
- IVC filter (Greenfield filter) indications
  - Patient has a contraindication to anticoagulation (GI bleed, etc)
  - Has a PE while anticoagulated
  - Has a recurrent DVT/PE
Varicose Veins

- 40% of adults. 6% of adults get venous ulcer

Anatomy: Deep system is 85% to 90% of the venous return. (more important) flow is from superficial to deep

Primary Varicose Veins: Not associated with other perforating or deep venous involvement

- Most common cause: incompetence of saphenofemoral valve

Natural History: Incompetence of this SF valve progressively dilates and results in incompetence of distal valves

Symptoms: heaviness and fatigue after long periods of standing, night cramps, superficial thrombophlebitis

Diagnosis

- Duplex, gold standard
- Venography is rarely needed and may cause phlebitis
- Plethymography

Treatment

- Strip the saphenous vein
- Saphenous ligation
- Radiofrequency ablation of saphenous
- Branch vein excision

Secondary Varicose Veins and Ulcers: Associated with an underlying cause such as DVT

Symptoms: Swollen and pigmented ankle. Pigmentation results from lipodermatosclerosis, a complication of chronic venous hypertension where the vein is fibrosed and leaks RBCs. Hemosiderin deposition results.

Diagnosis: Ultrasound

Treatment: Nonsurgical (compression hose but compliance is poor), Radiofrequency ablation

Thoracic Outlet Syndrome: Compression of the brachial plexus

- Neurological: Parasthesias of the arm and hand
- Arterial: coldness, pallor, muscle fatigue

Causes:

- Elongated transverse process of seventh cervical vertebra
- Fully developed cervical rib
- Congenital bands in the outlet related to the rib, middle scalene muscle or anterior scalene muscle
- Narrowed costoclavicular space, often because of a previously fractured rib or clavicle

Diagnosis

- Adson’s Test: Disappearance of the radial pulse on abduction and external rotation of the shoulder
- Cervical spine radiographs
- Nerve conduction velocity across the outlet

Treatment: Physical therapy, Botox. Surgical treatment if symptoms persist.

Sources:

- Essentials of General Surgery, 4th edition, 2006, Peter E. Lawrence, Lippincott Williams & Wilkins
- NMS Surgery Casebook, 2003, Bruce E. Jarrell, Lippincott Williams & Wilkins
- Surgical Recall, 5th edition, 2009, Lorne H. Blackbourne, Lippincot Williams & Wilkins